Title Page

FINAL TECHNICAL REPORT
Qualification and Demonstration Program for SSCL Lighting Systems
In Park and Highway Applications

Report Type: Final
Reporting Period Start Date: 3/22/2002
Reporting Period End Date: 6/30/2005
Principal Author: Don Osborne, Meadow River Enterprises, Inc.

Date Report Completed: April 3, 2006

DOE Award Number: DE-FC26-02NT41433

Submitting Organization: Meadow River Enterprises, Inc.
Att: Don Osborne
125 Alta Mountain Road
Lewisburg, WV 24901
Tel: 304-645-1972

DISCLAIMER

ABSTRACT

Meadow River Enterprises, Inc. (MRE) received a DOE cooperative agreement award in March of 2002 to develop Qualification and Demonstration Program for SSCL Lighting Systems in Parks and Highway Applications. (The SSCL lighting technology is the same technology that was developed under a DOE cooperative agreement DE-FC26-99FT40631.) This project spanned a period of 39 months and ended in June of 2005. Participates in the funding of this project included the US Department of Energy, Rahall Transportation Institute, West Virginia State Parks System, and Meadow River Enterprises, Inc. The total program costs totaled $850,000. The federal contribution to the program totaled $ 150,000 which represented 17.6% of the total costs.

The SSCL is a rugged electroluminescent lamp and was designed for outdoor applications. However, since this is a new technology, there have never been any housing or solar packages assemble for its use in these outdoor applications. The purpose of this program was to develop several types of encasements and solar packages, then evaluate their performances over time. At the end of observations, a conclusion would be reached as to the methodology of encasement and solar package requirements. In addition this project was to evaluate the viability of this application for the SSCL product. In addition this project was to evaluate the feasibility of etching the top conductive layer of the SSCL panel to permit only the needed area to be illuminated; this would reduce the power requirements of a sign.

All primary development objectives have been achieved.

TABLE OF CONTENTS

1.0 INTRODUCTION

The following report is the final Technical Report for the Qualification and Demonstration Program for SSCL Lighting Systems in Park and Highway Applications. As it has been stated and will be stated throughout this report; the main objective of this program was to develop a methodology for the construction of and field testing of outdoor signage that utilizes the SSCL product. It will be reflected in this report that these objectives have been accomplished.

2.0 EXECUTIVE SUMMARY

2.1 BACKGROUND

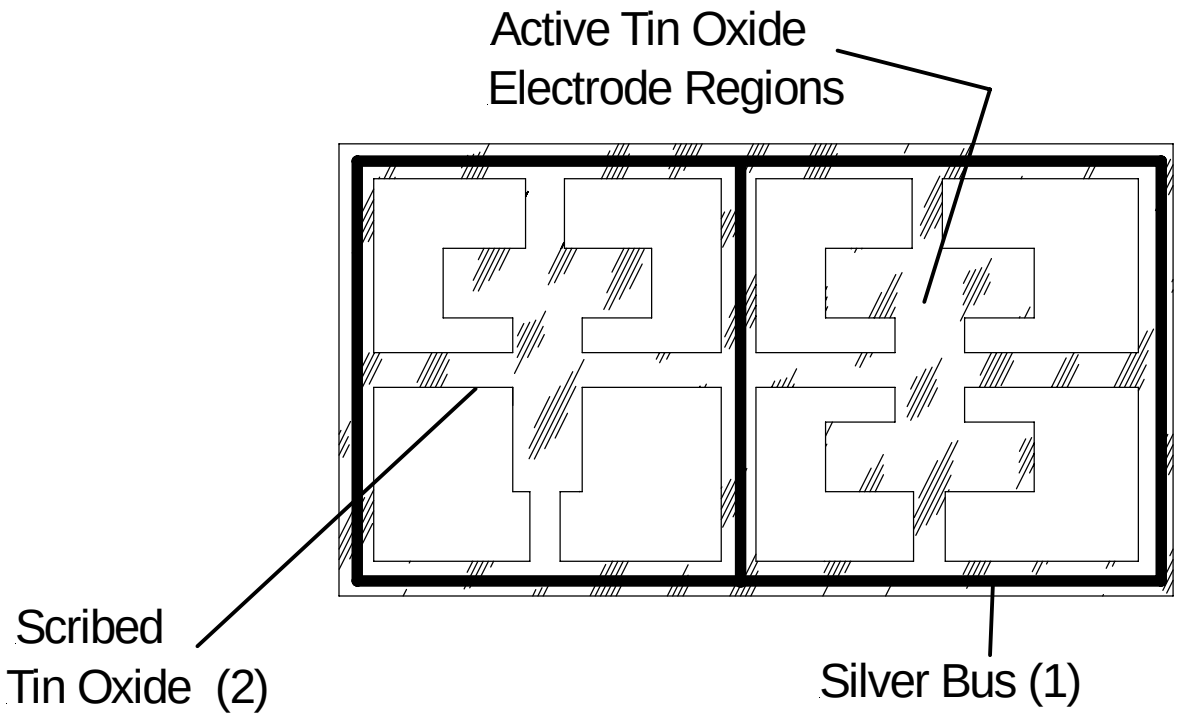
During the first calendar quarter of 2002, Meadow River Enterprises, Inc. entered into a cooperative agreement with the US Department of Energy (DE-FC26-02NT41433) . This agreement was to facilitate research that would lead to the methodologies that would permit the use of the SSCL product in outdoor applications such as highway signs and commercial signs. As stated in the Abstract, the total project costs were $850,000. The US Department of Energy supplied $150,000 and Meadow River Enterprises supplied the remaining $700,000. The remaining $700,000 expenditure was shared by Meadow River Enterprises, the Rahall Transportation Institute, and the West Virginia State Parks (through the West Virginia Economic Development Office.)

2.2 OBJECTIVES & STATUS

The purpose of the Validation Program was to provide evaluation and testing of Meadow River Enterprise's ceramic lamp panel for use in outdoor sign applications. This evaluation and testing was needed to launch a commercial marketing program. This marketing program will lead to manufacturing and jobs for the State.

This project was broken into 3 segments. The first segment tested the feasibility of etching the top conductive layer of the SSCL panel. (Drawing Number 1) The second segment consisted of the encasements of small SSCL panels that tested encasement techniques and electrical termination techniques. Observations were made during this first segment and recorded. (Photo Group 1.) The third segment consisted of placing SSCL lamps into actual signs and locating them at various State Park locations. The method of encasements for the Park and Highway Signs used the best known at the time of construction. These signs were observed for degradation throughout the project and corrections were made as problems occurred. (Photo Group 2)

During the first segment of the project a CNC router was used to mechanically etch the conductive layer. Extensive testing reflected that while this method of reducing the power consumption worked, it was not economically feasible to add this step to the manufacturing process.



Drawing Number 1

During the second segment of the project we tested 4 methods of SSCL panel protection: epoxy coating, unprotected panels, panels that were hermetically sealed, and panels that were encased in a clear cast UV stable 2 part urethane resin. This segment yielded a method of panel protection that will work in all outdoor environments and applications.

Bare Lamp

2 Part Epoxy

RTV Sealed

2 Part Clear Cast

Photo Group 1

During the third segment of the Product Validation Program Meadow River placed 65 lamp panel units into service at Pipestem and Cacapon State Parks. This initial installation was to give us adequate product to facilitate third party testing and evaluation. This testing ultimately resulted in a product that will enable future commercialization opportunities. Unfortunately there were numerous problems that occurred during this testing. The data collected and the observations that were made allowed for corrections to the product. These corrections came too late in the project to permit adequate 3rd party evaluations. As of this date, the product applications are doing well.

Informational Sign

Road Sign Pipestem State Park

Photo Group 2

3.0 EXPERIMENTAL

3.1 Mechanical Etching of Conductive Layer

The SSCL panel has a top clear conductive layer that provides a surface by which the electrical charge can be distributed across the surface of the lamp panel. If this layer is broken, the area that is broken will not conduct the charge and therefore will not illuminate. This fact can be used to manufacture a lamp panel that will only have certain areas illuminated. To facilitate the testing of this manufacturing process, a CNC table router was retrofitted with a tool post that would only cut through the thin top conductive layer. (see drawing 1.) This method of etching proved to work.

3.2Outdoor Protection of the SSCL Lamp Panel

Four methods of SSCL panel protection were tested: ***epoxy coating***, ***unprotected panels***, ***panels that were hermetically sealed***, and ***panels that were encased in a clear cast UV stable 2 part urethane resin.*** (See Photo Group 1) A 5"x 10" SSCL lamp panel was used in each of these tests.

The epoxy coating test was conducted by routing out a cavity in a block of ¾" 15 lb sign foam, placing the panel into the cavity and then poring a ½" thick layer of 2 part epoxy over the panel.

The unprotected panel test was conducted by routing out a cavity in a block of ¾" 15 lb sign foam, placing the panel into the cavity and then placing a clear polycarbonate cover over the panel/foam assembly.

The hermetically sealed test was conducted by routing out a cavity in a block of ¾" 15 lb sign foam, placing the panel into the cavity and then placing a clear polycarbonate cover over the panel/foam assembly. The polycarbonate was then sealed using a RTV silicon sealant.

The clear cast UV stable 2 part urethane resin was conducted by routing out a cavity in a block of ¾" 15 lb sign foam, placing the panel into the cavity and then poring a ½" thick layer of 2 part urethane resin. This resin was manufactured by Smooth-On and was their formulation Clear Cast 202.

3.4 Product Application Evaluation

There were 65 lamp panel units into service at Pipestem and Cacapon State Parks. Initially, all of these units were constructed by using wood. The wood was routed to form the letters and a cavity was made to hold the lamp panel unit. The initial lamp panel units were protected using the hermetically sealed method of encasement. As will be discussed

later, the wood proved not to be a desirable platform and the hermetically sealed panels proved not to be an adequate method of lamp panel protection. These signs were replaced using a 15lb urethane sign foam and the panels were encased using the 2 part UV stable urethane resin. The lettering was accomplished by the same method used with the wooden sign; routing. A beveled edge was provided for each letter. This beveled edge was painted a different color to provide daytime contrast.

4.0 RESULTS AND DISCUSSION

4.1 Mechanical Etching of Conductive Layer

The mechanical etching proved to work. In practical application, a laser cutting method may prove to work more efficiently than the CNC routing method. The conclusion to these test indicate that in most applications, the added cost to manufacturing does not justify the reduction in power consumption.

4.2 Outdoor Protection of the SSCL Lamp Panel

Observations of these tests reflect that the unprotected panel will not last in outdoor applications; degradation of the lamp panel occurred after 30 days of observations. The hermetically sealed panels worked about 50% of the time. It is suspected that thermal expansion caused by the sun caused small leakages around the edges and allowed moisture to enter the cavity. The 2 part epoxy encased lamp panels had some separation of the epoxy from the surface of the panel; this did not affect the performance of the panel. However, the epoxy was yellowed by UV and thus did not prove to be an adequate encasement. The 2 part clear cast urethane method of encasement proved to work well in all conditions. The urethane adhered well to the lamp panel, gave complete protection from moisture, and did not show any evidence of yellowing caused by UV radiation. This method of encasement continues to be working in all of the ongoing tests.

4.3 Product Application Evaluation

Some of the observations of this evaluation are as follows:

These initial installations revealed numerous problems we did not anticipate. The problems were not with the lamp panels themselves, but with the packaging and electronics. The major problems that occurred were:

- Lightning induced power spikes resulting in failed contacts

- ♦ Daytime visibility due to the package color contrast with the lamp panel's surface
- ♦ Rusting of the lamp panels caused by inadequate weatherproof seal of the package.
- ♦ Wood is not a satisfactory material for the use of the SSCL lamp panel in sign applications
- ♦ The standard solder terminations is not satisfactory for outdoor applications

These problems rendered a satisfactory third party evaluation useless.

As a result of discovery these problems, we have developed a sign package for our lamp panels that is:

- ✓ Modular in design so that it can be used to retrofit an existing sign as easily as it can be used on a newly constructed sign.
- ✓ Weather proof to the degree of stability from –20F to 160F, the package is both water and moisture proof.
- ✓ We have designed the electronics associated with the lamps that will adequately protect the panels from power spikes.
- ✓ We can use a thin florescent film to give the letters a daytime contrast. (see Photo 3)
- ✓ The use of 15lb urethane sign foam to replace the wood construction appears to solve the various problems associated with wood.

As was stated earlier, the first signs constructed were manufactured using wood and the lamp panels were protected using the hermetically sealed method. The wood warped and aged rapidly. Many of the hermetically sealed lamp panels failed as well. Another observation that was made during this testing was the tendency of the electrical terminations on the lamp panels to fail. The historical method of termination was to use a conductive silver epoxy and then solder the termination wire to this epoxy. We changed this termination to a mechanical termination. Thus far this termination has proven to be 100% effective. The signs at Cacapon and Pipestem State Parks have been replaced using these new methods of construction. To date, these signs are performing well. The only problems noted are associated with the inadequacy of the solar power due to the shading of the trees. The solution to this problem is to increase the size of the solar collectors and the increasing of the battery capacity.

5 CONCLUSIONS

In conclusion, it would have been nice if there had been no problems with the initial installations of the outdoor sing applications of the SSCL lamp panel. However, it was far better that these problems occurred during testing and not after commercialization. All of the problems that occurred appear to be solved. The information gathered to date under this Validation Program has yielded extremely valuable information that will make entry into the commercial market much easier.

To date, the Validation Program has succeed in giving Meadow River the information and field testing that it has needed for its commercialization efforts. Using this information, a more reliable and market ready product can be obtained within a time frame of months instead of years.